MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

PPH0105 – MODERN PHYSICS & THERMODYNAMICS

(Foundation in Engineering)

5 MARCH 2019
2.30p.m – 4.30p.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **THREE** printed pages, excluding the cover page and appendixes, with **FIVE** questions.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Write all your answers in the Answer Booklet provided.
4. All necessary workings **MUST** be shown.

Answer **ALL** questions.

QUESTION 1: [10 Marks]

a) A certain transverse wave is described by

$$y = (14.4)\cos\left[2\pi\left(\frac{t}{0.03} - \frac{x}{15} + \frac{1}{6}\right)\right]$$

where y, x are in millimeter and t is in second, Determine the wave's

i) amplitude, wavelength, frequency, speed of propagation and direction of propagation. (4 marks)

ii) Determine the displacement, y of the transverse wave at point $x = 5$ mm and $t = 0.15$ s. (1 mark)

b) i) What is Doppler effect? (1 mark)

ii) A car sounds its horn while approaches a stationary observer at a constant speed. The frequency detected is 106 Hz. After the car goes by, the observer hears a frequency of 100 Hz. What could be the speed of the car? (The speed of sound in air is 340 m/s) (4 marks)

QUESTION 2: [10 Marks]

a) If 700 nm and 600 nm light passes through two slits 0.60 mm apart, how far apart are the second-order fringes for these two wavelengths on a screen 2.0 m away? (5 marks)

b) The prism in Figure Q2 has an index of refraction of 1.40. Light is incident at an angle of 15°. Find the angle ϕ at which the light emerges. (5 marks)

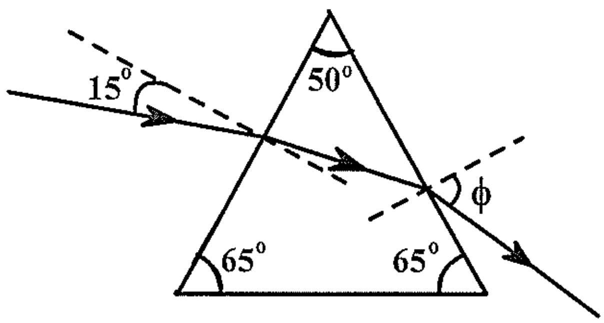

Figure Q2

Continued...

QUESTION 3: [10 Marks]

a) What is electronvolt? (1 mark)

b) What is the energy in a photon of green light of wavelength 5.46×10^{-7} m. Give your answer in electronvolts. (2 marks)

c) State Einstein's photoelectric equation and explain each term. (2 marks)

d) Sketch a graph of the maximum kinetic energy of photoelectrons as a function of the incident frequency of light on a material when the photoelectric effect takes place. (2 marks)

e) Sketch a graph of current against the retarding potential for two different intensities of light. Show the stopping potential. (3 marks)

QUESTION 4: [10 Marks]

a) A sample of organic material is found to contain 18.0 g of carbon and has an activity of 86.5 decays / min. It is known that carbon from a living organism has a decay rate of 15.0 decays / min.g and ^{14}C has a half-life of 5730 year. How old is the organic material? (4 marks)

b) A typical fission reaction in a nuclear power plant is

$$^{235}U + {}^{1}n \rightarrow {}^{140}Xe + {}^{94}Sr + bn + Q,$$

where mass of : ^{235}U = 235.043923 u, ^{140}Xe = 139.921636 u, ^{94}Sr = 93.915360 u, n = 1.008665 u, and b is some number of neutrons.

i) What is the value of b? (1 mark)

ii) Calculate the energy produced, Q. (2 marks)

iii) Calculate the mass of the ^{235}U consumed each year by a 300 MW power plant operating at 60% efficiency of conversion of heat to electricity. (3 marks)

Continued...

QUESTION 5: [10 Marks]

a) Define Heat. (1 mark)

b) Two equal mass objects make up a system that is thermally isolated from its surroundings. One object has an initial temperature of $80\,^{\circ}\mathrm{C}$ and the other has an initial temperature of $0\,^{\circ}\mathrm{C}$. What is the equilibrium temperature of the system, assuming that no phase changes take place for either object? (The hot object has a specific heat capacity twice that of the cold object.) (4 marks)

c) A leaf of area $20\ \mathrm{cm}^2$ and mass $2.0\times10^{-4}\,\mathrm{kg}$ directly faces the Sun on a clear day. The leaf has an emissivity of 0.85 and a specific heat of $3350\ \mathrm{J/kg\cdot K}$. On a clear day, about $1000\ \mathrm{W/m^2}$ reaches the Earth's surface. Estimate the rate of rise of the leaf's temperature. (5 marks)

End of paper

APPENDIX I

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 / kg^2
Universal gas constant,	R	=	8.314 J/mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23}J/K
Compton wavelength,	λ_c	=	2.426×10^{-12}m
Planck's constant,	h	=	6.63×10^{-34}J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^{8}m/s
Rydberg constant,	R_H	=	1.097×10^{7}m^{-1}
Acceleration due to gravity of earth,	g	=	9.80 m/s^2
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19}J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_0	=	1.0×10^{-12} W/m^2
Coulomb constant,	$k = \dfrac{1}{4\pi\varepsilon_0}$	=	9.0×10^{9} N.m^2 /C^2
Permittivity of free space,	ε_0	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ T.m/A
1 atmosphere pressure,	1 atm	=	1.0×10^{5} N/m^2
			1.0×10^{5} Pa
Wein's displacement constant		=	0.2898×10^{-2} m.K
Speed of Sound in Air		=	343 m/s
Refractive index of air/vacuum	n	=	1.0
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^{3} km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^{3} km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^{5} km
Earth-Sun distance (mean),		=	149.6×10^{6} km
Earth-Moon distance (mean),		=	384×10^{3} km

APPENDIX II

LIST OF FORMULAS

$\sin\theta_1 + \sin\theta_2 = 2\sin \tfrac{1}{2}(\theta_1 + \theta_2)\cos\tfrac{1}{2}(\theta_1 - \theta_2)$

$\cos\theta_1 + \cos\theta_2 = 2\cos \tfrac{1}{2}(\theta_1 + \theta_2)\cos\tfrac{1}{2}(\theta_1 - \theta_2)$

$\sin\left(\theta + \dfrac{\pi}{2}\right) = \cos\theta$

$\sin\theta \approx \tan\theta \approx \theta$ *rad* for small angle

$D(x, t) = D_M \sin(kx \pm \omega t \pm \phi)$

$v = \sqrt{\dfrac{F_T}{\mu}}$ $\quad$ $v = \sqrt{\dfrac{\text{elastic property of the medium}}{\text{inertia property of the medium}}}$

$\lambda_n = \dfrac{2}{n}L$ $\quad$ $f' = f\left(\dfrac{v \pm v_o}{v \mp v_s}\right)$ $\quad$ $\dfrac{1}{d_o} + \dfrac{1}{d_i} = \dfrac{1}{f}$

$\dfrac{1}{f} = (n-1)\left\{\dfrac{1}{R_1} + \dfrac{1}{R_2}\right\}$ $\quad$ $d\sin\theta = m\lambda$ $\quad$ $d\sin\theta = \left(m + \tfrac{1}{2}\right)\lambda$

$\lambda_m . T = 0.2898 \times 10^{-2}$ $\quad$ $I(\lambda, T) = \dfrac{2\pi c k_B T}{\lambda^4}$

$E_n = -\dfrac{mk^2Z^2e^4}{2\hbar^2}\left(\dfrac{1}{n^2}\right)$ $\quad$ $r_n = \dfrac{\hbar^2}{mkZe^2}n^2$ $\quad$ $L = mvr_n = n\hbar$ $\quad$ $\hbar = h/2\pi$

$\dfrac{1}{\lambda} = R_H\left[\dfrac{1}{n_i^2} - \dfrac{1}{n_f^2}\right]$ $\quad$ $\dfrac{1}{\lambda} = \dfrac{mk^2 Z^2e^4}{4\pi c\hbar^3}\left[\dfrac{1}{n_f^2} - \dfrac{1}{n_i^2}\right]$ $\quad$ $\lambda = \dfrac{h}{p}$ $\quad$ $\Delta E = hf$

$N = N_0 e^{-\lambda t}$ $\quad$ $R = R_0 e^{-\lambda t}$ $\quad$ $\lambda = \dfrac{\ln 2}{T_{1/2}}$ $\quad$ $Q = (M_X - M_Y - M_\alpha)c^2$

$\Delta L = \alpha L_0 \Delta T$ $\quad$ $PV = nRT$ $\quad$ $k = \dfrac{R}{N_A}$ $\quad$ $Q = mc\Delta T$ $\quad$ $Q = mL$

$\dfrac{\Delta Q}{\Delta t} = -kA\dfrac{\Delta T}{\Delta L}$ $\quad$ $\dfrac{\Delta Q}{\Delta t} = e\sigma AT^4$ $\quad$ $\dfrac{\Delta Q}{\Delta t} = IeA\cos\theta$

$\overline{\text{KE}} = \tfrac{1}{2}m\bar{v}^2 = \tfrac{3}{2}kT$ $\quad$ $U = \tfrac{f}{2}nRT$ $\quad$ $\Delta U = \dfrac{f}{2}nR\Delta T$ $\quad$ $Q = \Delta U + W$

$W = \int dW = \int_{V_i}^{V_f} P\,dV$ $\quad$ $W = P(V_f - V_i)$ $\quad$ $W = nRT\ln\left(\dfrac{V_f}{V_i}\right)$